

The Nature of Man's Adaptation to His Total Environment and the Relation of This to Illness

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The modern investigation of how man's adaptation to his environment affects his health dates from Claude Bernard. During the succeeding century, there has been a continued interest in the field in which Bernard pioneered, and the number of those working in the area has increased steadily. Information has been gathered from sources as diverse as neurology, endocrinology, cultural anthropology, and the statistics of time series,¹ each part of which has contributed to general concepts which could not have been constructed even so recently as 10 years ago. The purpose of the present paper is to describe some of the findings from a study carried out by us and our colleagues,* which is concerned with the distribution of illness in three population groups, the influence of environmental factors upon this, and its significance in the light of our knowledge derived from laboratory experiments.

Methods

Over the past five years, members of our group at the New York Hospital-Cornell Medical Cen-

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ter have carried out investigations of the distribution of illness in three homogeneous population groups totalling 2924 persons (Table 1). The first of these groups was made up of 1297 adult women, all of whom were healthy as ascertained by physical examination and medical history at age 14 to 18. These women were of second generation Irish and Italian descent, of upper-middle-class background (Warner and Lunt²) with grammar-school educations. They had spent their lives in a large city with uniform and adequate sanitation, where they mingled freely with the general population and had ample opportunity for exposure to the pathogenic agents present. From the time of their initial examination onward for periods as long as 30 years, they had all been constantly employed in the same unskilled but relatively well-paid, nonhazardous work, for a corporation which maintained complete records of their health and attendance. These records included a description of every illness causing absence from work, periodic physical examinations, reports from private physicians, and diagnostic reports from hospital admissions.

In this group of 1297 women, there were 336 who had been continuously employed for 20 years or more. The distribution of illness in the entire group was studied, but special attention was also given to the 336 with long service. From this long-service group there were selected the 20 women with the greatest number of total days of sickness disability and the 20 with the smallest number. These women were examined individually, and extensive histories were obtained from them during interviews lasting several hours; extensive personal histories were obtained also. A similar procedure was followed with more than 60 women selected at random from among those having intermediate amounts of illness.

The second group studied was made up of 1527 adult men employed by the same corporation. This group was homogeneous with regard to all the factors described for the women, but was different in the following features: Its members were largely third-generation Americans, primarily of Irish and Italian descent, but including approximately 25% of German or English protestant descent. They were of lower-middle-class back-

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TABLE 1.—*Characteristics of the Three Groups*

	Group I	Group II	Group III
1. Total number studied	1,297	1,527	100
2. Number studied intensively	336	279	100
3. Age	17-50	17-55	19-72
4. Sex	Women	Men	Men and women
5. Cultural background	2d generation Irish and Italian American	Mixed indigenous American	Chinese
6. Socioeconomic background	Upper lower class	Lower middle class	Upper class
7. Education	Grammar school	High school	College
8. Occupation	Unskilled white-collar	Skilled workmen	Graduate students, professional men
9. Lifetime environment	Metropolitan New York	Metropolitan New York	Various parts of China (later United States)
10. Sanitation of general surroundings	Generally high	Generally high	Generally very low
11. Exposure to pathogens and trauma	Low	Moderate	High
12. Physical deprivations, pressures, and dislocations	Few	Few	Many
13. Social dislocations and situations of uncertainty	Few	Few	Many

ground, with high school educations, and were employed as skilled workmen. Similar records were available on these men, of whom 279 having more than 20 years of unbroken service were selected at random for intensive study. The investigative procedure for this group was similar to that used with the group of women.

The third group was made up of 100 adult Chinese men and women, now mostly in the fourth decade of life. These people were all born in China and came to the United States approximately 10 years before as graduate students. Because of the changed political situation in China they have been unable to return and have remained in this country in a situation of uncertainty since that time. They were all, of course, of Chinese descent, although they came from various parts of China. They came largely from well-to-do families of established positions in their communities. Almost all of them had completed college, and most had higher degrees. In general, they had looked forward to careers as scholars, administrators, government officials, and members of various professions.

This group also was unselected with regard to health. Each member of the group was studied for 16 hours in the following manner: Four hours was spent in obtaining a complete medical history and physical evaluation, with diagnostic tests; this was carried out by a physician; four hours was spent in interviews with a cultural anthropologist (supplemented, in some instances, by a sociologist) who obtained a biographical statement, as well as other information relating to the position of the informant in relation to his social environment, both in China and the United States. Four hours was spent with a psychiatrist, who focused upon an evaluation of the personality structure of the informant, his perception of his life experiences, and an estimate of their meaning to him. Four hours was spent with a clinical psychologist, who utilized a battery of tests which included the Wechsler-Bellevue Intelligence Scale, Form I, the

Rorschach, the Lowenfeld Mosaic, a Projective Questionnaire, Sacks Sentence Completions, Thurstone Temperament Scale, and Human Figure Drawings. The Thematic Apperception Test was administered to about 30 of the informants also. Each of these observers studied the informants independently and gathered his data independently; later the informants were discussed at conferences of the four disciplines.

There was, of course, no independent record of the illnesses which these Chinese had experienced, and it was necessary to use their own memories in order to obtain this information. Experience with the two American groups, in which medical histories given from memory were compared with medical records obtained independently, showed that statements about major illnesses, as described from memory, were in general remarkably accurate and that estimates of minor illnesses were close enough to provide a reliable general indication of the informants' state of health with regard to these. Evidence obtained from the description of illness given in each Chinese informant's medical history, evaluated in the light of the assessments made by the psychiatrists and psychologists, was also used to evaluate the data. It is our opinion that the health of these Chinese informants, as measured by our methods, is a reliable reflection of their true state of health.

Each of these groups was selected in part because its members had shared an essentially equal exposure to the various aspects of a common physical environment and an essentially equal opportunity to encounter the various external causative agents which are known to be relevant to the development of disease. Each of the American groups was made up of steadily employed people with adequate incomes, living in adequate housing, with adequate and varied diets, and mingling intimately with members of a large metropolitan population. The Chinese had been irregularly employed and had experienced fluctuations in their income, housing, and diets. All of them had been

exposed to the inadequate sanitation and flourishing pathogenic agents of China. They had all experienced physical dislocation and physical hardships during the wars and social upheavals which have occurred in China in the last three decades, and for the group as a whole these experiences were essentially equal.

Results

1. The distribution of illness among the members of each of these three groups was not a random distribution. A significant proportion of each group had experienced far more than the amount of illness to be expected if chance alone were the determining factor. The distribution curves for the three groups were remarkably similar. That for the group of American men is shown in Figure 1. This is not a Poisson † distribution, as one might expect if chance

†The "Poisson" distribution is a mathematical description of the distribution of rare events when each event is independent of the others.

were the sole determining factor.⁶ The distribution most resembles the negative binomial distribution that occurs in groups when the members of the group have different "risks" (or, in nonstatistical terms, "likelihoods") of becoming ill. This point has been examined statistically with great care, especially among the group of American men. It is quite clear that, in spite of the homogeneity of each of these groups with regard to the characteristics of its members and of the physical environment shared by them, some members of each group had a greater "risk" of becoming ill than others.

This difference in risk was not limited to one point in time but clearly extended over a period of years. For example, the number of illnesses experienced by each man in the American group during the first 5 years of the observation period showed a positive correlation with the number of

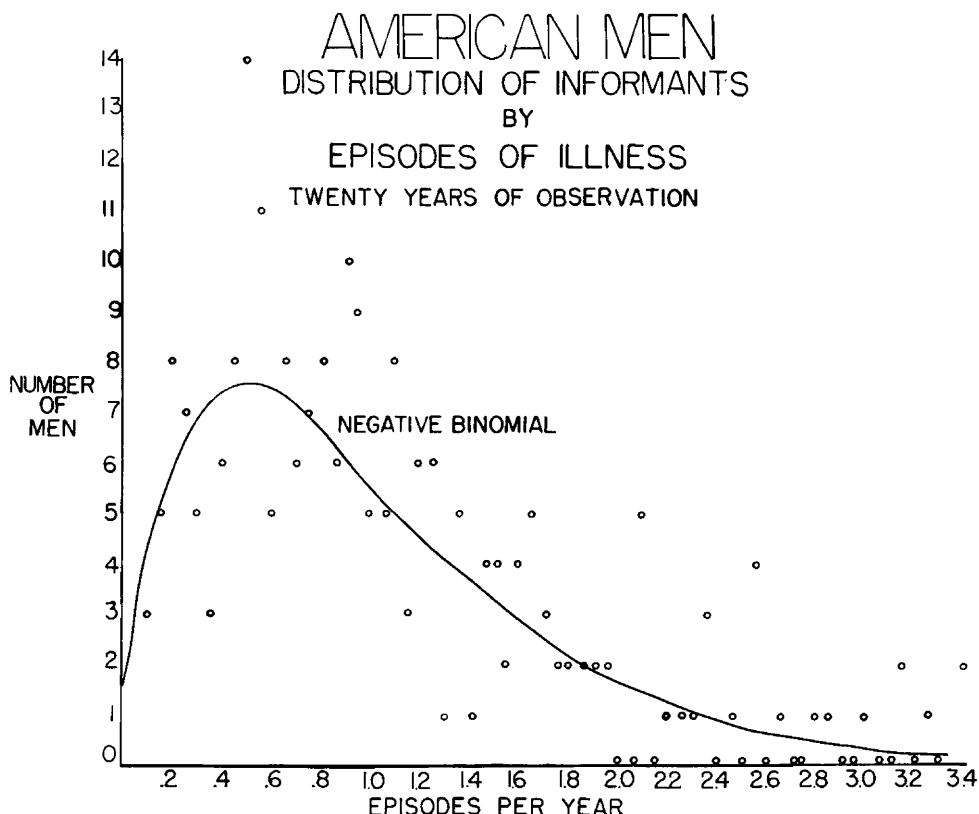


Figure 1

episodes of illness experienced during the subsequent 15 years. The findings are similar in the other two groups.

Our inference from these findings is that marked differences in susceptibility to illness occur among the members of the general population, that these differences last for a number of years, and that they are related to some factor (or factors) which operate similarly in all of these groups.

2. The nature of the illnesses experienced groups was examined. In every group it was found that those members having the greater number of illnesses experienced a by the individual members of each of these wide variety of illnesses, both major and minor, in a number of body systems. There was a positive correlation between the number of episodes of illness experienced by each person and the number of body systems involved in these illnesses. Figure 2, taken from the study of the Chinese, illustrates this. It was common to find that

one type of illness, such as upper respiratory infections, gastrointestinal disturbances, migraine headaches, or recurrent episodes of anxiety, might appear as a recurring feature in the health history of a person, but no person was found who had a great many illnesses limited to one or even to two or three body systems. All of those who had many illnesses involving one body system usually had other illnesses, and some serious illnesses, involving other body systems. Furthermore, there was a general parallelism between the number of "major" illnesses and the number of "minor" illnesses which one man experienced. As a group, those having the greater number of minor illnesses also had the greater number of major illnesses, and these major illnesses usually involved the body systems which were most frequently involved in the minor illnesses. Figure 3, taken from the group of American men, illustrates this.

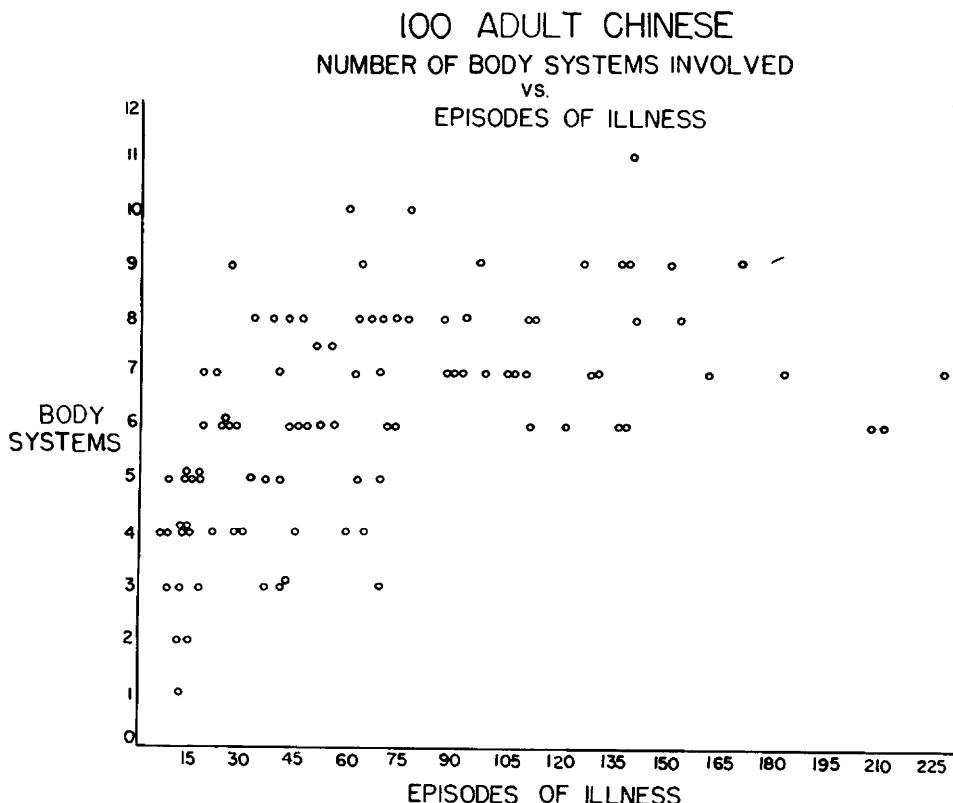


Fig. 2.—Study of 100 adult Chinese; $r=0.65$, $r^2=0.422$, $P<0.01$.

AMERICAN MEN MAJOR vs. MINOR ILLNESSES

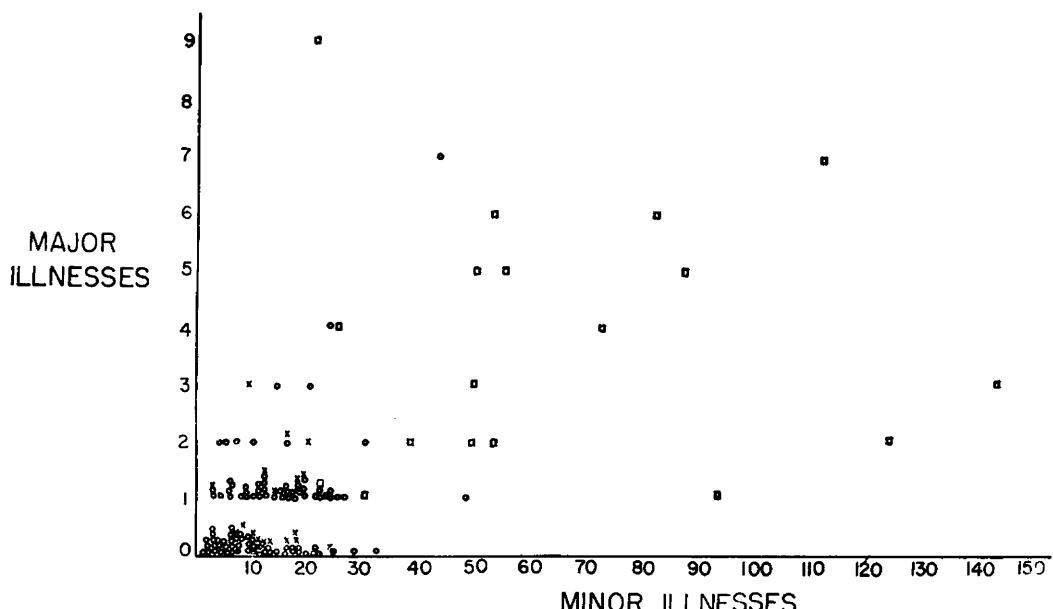


Fig. 3.—Study of American men; $r=0.40$, $r^2=0.160$, $P<0.01$.

There was a similar relationship between the so-called "bodily illnesses" and disturbances of mood, thought, and behavior; that is to say, those people who had the greater number of bodily illnesses, regardless of their nature and regardless of their etiology, were the ones who experienced the greater number of disturbances of mood, thought, and behavior (Fig. 4, from the Chinese study). For example, not uncommonly, persons were seen with recurrent episodes of anxiety, depression, chronic obsessive and compulsive symptoms, or character disturbances; symptomatology of this type, with exacerbations and remissions, might predominate in their illness patterns throughout life. But such people, as a group, also had more bodily illnesses of all types than were found among those who had few or no disturbances of mood, thought, or behavior. This can be put in other terms by saying that, in all three of the groups studied, there was a parallelism between the occurrence of psychoneuroses and psy-

chooses and the occurrence of bodily illnesses. There was a similar relationship between illnesses and accidents (Fig. 5, American men).

Thus those who had the greater "risk" of becoming ill, and who therefore experienced the greater number of illnesses, showed an increased susceptibility to illness in general. (Table 2 is an example. This American woman was selected for study solely on the basis of the fact that she had had 1041 days of disability in 35 years.) Whatever factors were associated with the increased risk of illness affected susceptibility to all forms of illness. As a group, those who became ill most frequently were more likely to develop severe illnesses than those who became ill less frequently.

Our general inference from these findings is that "illness" is a state of the total organism, that when a human moves from a state of "health" into a state of "illness," the "illness" is likely to be manifested by a variety of syndromes appearing concur-

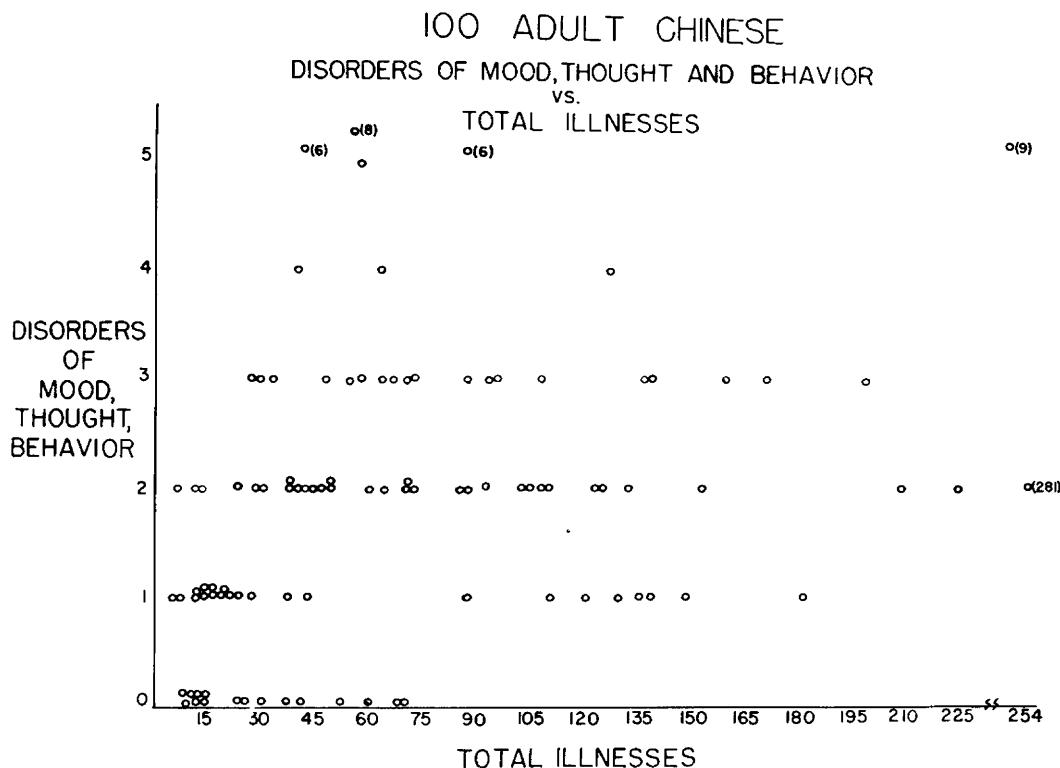


Fig. 4.—Study of 100 adult Chinese; $r=0.45$, $r^2=0.202$, $P<0.01$. For those having one or more episodes of disturbances of mood, thought, and behavior, $r=0.82$, $r^2=0.672$, $P<0.01$.

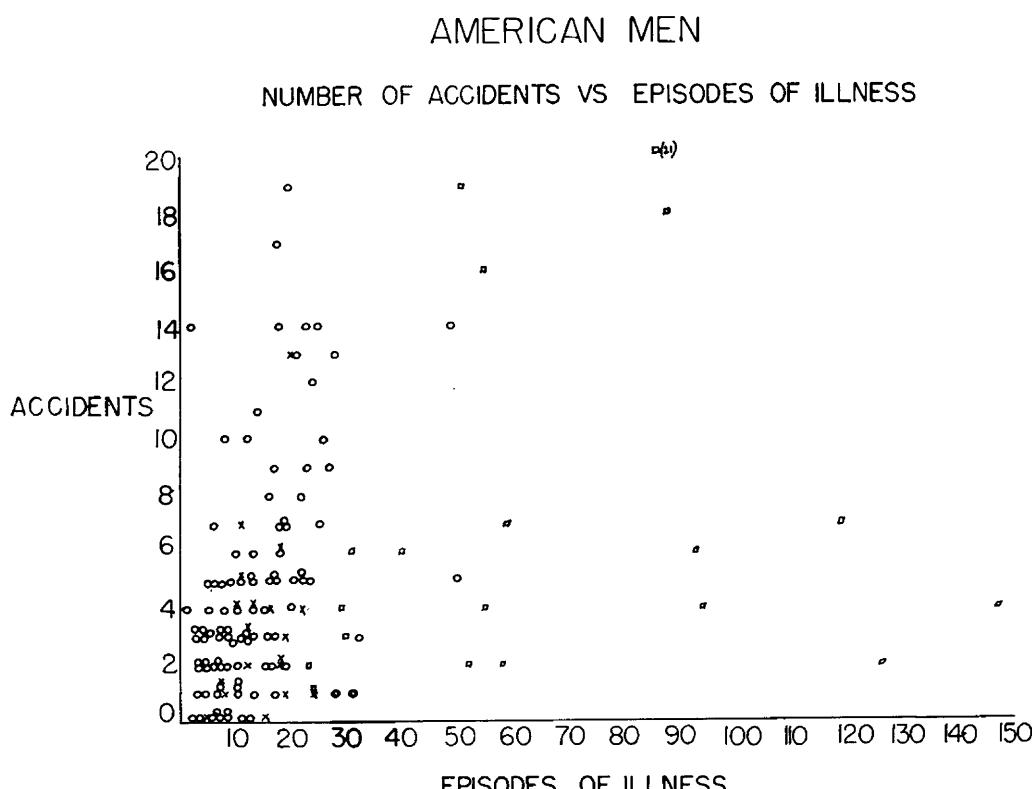


Fig. 5.—Study of American men; $r=0.5$, $r^2=0.25$, $P<0.01$.

TABLE 2.—*An "Ill" American Working Woman: Illnesses Experienced from Age Sixteen to Age Fifty-One*

"Body System"	Syndrome	Episodes of Disability
1. Respiratory system	Influenza; pertussis; minor upper respiratory infections; severe tonsillitis	(Approx.) 1 1 44 2
2. Gastrointestinal system	Cholecystitis and cholelithiasis; diaphragmatic hernia; duodenal diverticulum; postoperative biliary symptoms; mucous colitis; infectious gastroenteritis (chronic, nondisabling constipation, low abdominal pain, "gas," and nausea, present for many years also)	2 5 9 4 4 3
3. Cardiovascular system	Essential hypertension	0
4. Genital system	Myomata of uterus; dysmenorrhea (chronic); postmenopausal flushes, severe	1
5. Urinary system	Pyelonephritis; cystitis	1 1
6. Blood	Hypochromic anemia	
7. Musculoskeletal system	"Low back pain"; osteoarthritis	4 1
8. Head	Vascular headaches (nondisabling headaches occurred about once a month)	2
9. Ears	Otitis media; Ménière's syndrome	2 1
10. Eyes	Conjunctivitis	1
11. Teeth	Dental caries (total extractions)	3
12. Skin	Urticaria; cellulitis	2 1
13. Breast	Fibroma	1
14. Metabolic	Obesity	
15. Mood, thought, behavior	Moderately severe depressions; anxiety-tension states (symptoms of anxiety, tension, depression chronically present)	3 5
Accidents	Contusions; lacerations; sprains	8 3 1
Operations	1. Cholecystectomy 2. Hysterectomy and oophorectomy 3. Excision of fibroma of breast 4. Total dental extractions	
	Summary	
	Total days disabled	1041
	Disabling episodes of illness	95
	"Major" illnesses	9
	Disabling disturbances of mood, thought, and behavior	8
	"Body systems" involved	15
	Accidents	12
	Operations	4

rently or consecutively, their nature being dependent upon the various factors acting upon the organism at that time.

3. In order to ascertain the circumstances under which illness occurs, the sickness patterns of members of each group were studied intensively. Each illness episode was carefully located with regard to the time when it occurred in the life of the person. Among the subjects in all three groups, those having many illnesses as well as those having relatively few, it was found that illnesses were not scattered in a random fashion

throughout their lives. Instead, illnesses usually appeared in clusters (Fig. 6). There would be periods of years in the life of a person when he was relatively healthy, and other periods of years during which he would have a number of episodes of illness. One form of illness might predominate in such a cluster, but it was rare to find that one form alone appeared. Usually a cluster was made up of a variety of illnesses involving several body systems, running concurrently or consecutively, over a period of years and followed by a num-

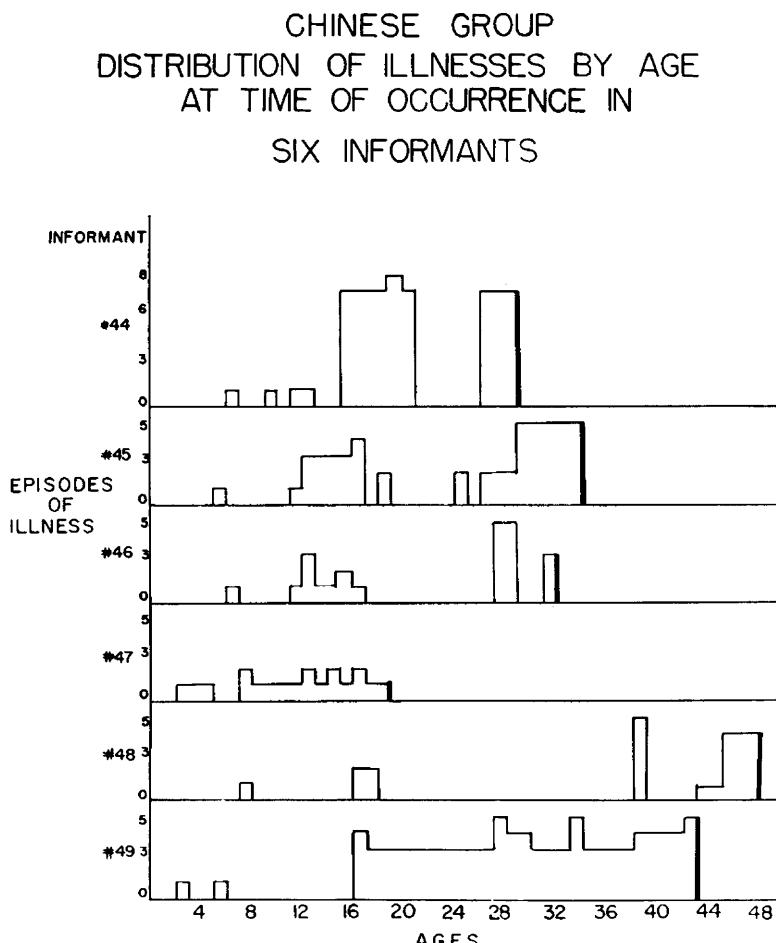


Figure 6

ber of years of relatively good health during which there were few illnesses of any sort (Fig. 7).

Such clusters were usually of 5 or 10 years' duration. Those seen in the American groups were perhaps somewhat longer than those seen in the Chinese. This appeared to explain why there was a positive correlation between the number of episodes of illness occurring in the informants during one period of years and that occurring during a subsequent period of years; the duration of these clusters was such that they usually overlapped the two periods which were being compared. However, it was not common to find anyone who had persistent and recurrent illnesses throughout his entire life; nor was it common to find others who had had

essentially no illness at any time in their lives. Even among those having the fewest episodes of illness, these illnesses often appeared in clusters covering a relatively few years.

Even though the three population groups were selected because they had shared similar physical and social environments and some similar life experiences, these factors were focussed upon intensively in the study of selected persons. Differences in exposure to physical hardships, dietary differences, differences in exposure to infectious or toxic agents, and differences in general physical life experiences did not appear to account for the differences in susceptibility to illness. In general, the lives of the most healthy and the lives of the least healthy

CHINESE STUDY
ILLNESSES EXPERIENCED BY ONE INFORMANT

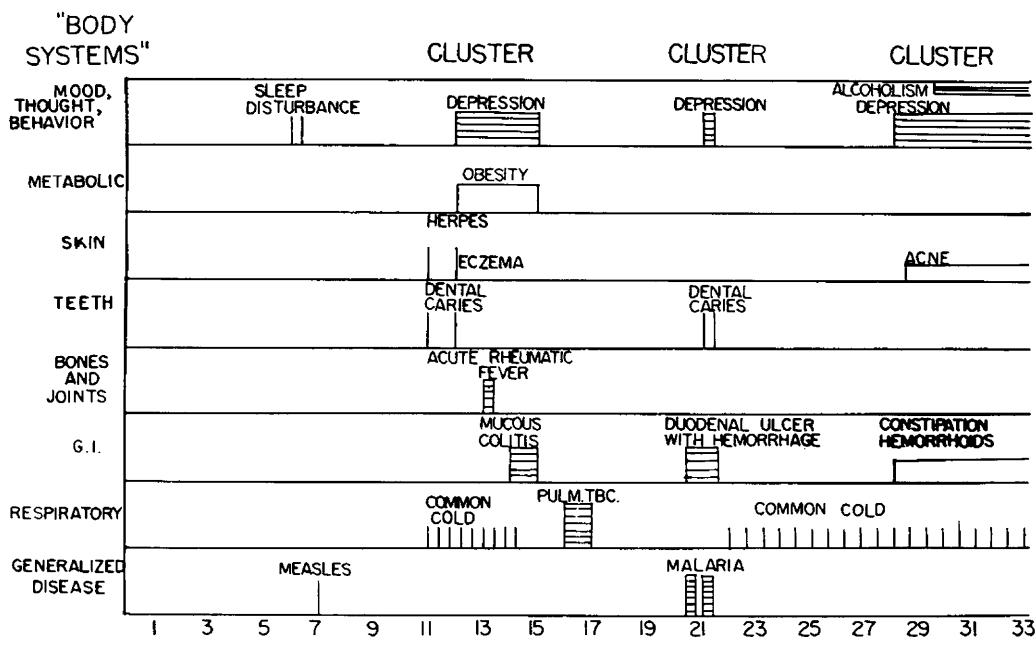


Figure 7

members of each group were similar with regard to these factors.

The life histories of the informants were examined in an attempt to see what correlation there was between the objective facts of the interpersonal and social adaptations which they had found it necessary to make and the occurrence of their illnesses. Here there was a difference, but it was by no means absolute. A large proportion of the most frequently ill members of the two American groups had been reared in families in which there was dissension and conflict between the parents, with hostile and rejecting attitudes on the part of one or both toward the children, divorces, emotional deprivation, and unusual restrictions or demands placed upon the offspring. Relatively few of the healthiest members of these groups had experienced any of this to a significant degree. The data from the Chinese group, which is still being evaluated, appear to show the same things.

However, there were demonstrably healthy people in all three groups who had been reared in family settings in which there was a marked degree of dissension, emotional deprivation, hostility, and restriction; furthermore, some of the people who during their adult lives were among the sickest in each group had been relatively healthy during the period of their apparently adverse experiences in childhood. Thus it seems that such "objectively" adverse childhood experiences are positively correlated with adult ill health; but they cannot be invoked as a satisfactory explanation for predisposition to illness in adult life, including the disturbances of mood, thought, and behavior. Table 3, taken from the study of the American women, illustrates this.

Similarly, a study was made of the association between the "objective" aspects of adult interpersonal relations and social demands and the occurrence of illness. It was found that during their adult lives a large

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TABLE 3.—*American Working Women: Summary of the Independently Observable Facts of the Background and Life Situation of the Most Healthy and the Least Healthy of the Members of the Group*

	"Well Group"	"Ill Group"
1. Heredity	No major difference	None
Familial diseases	None	None
2. Health of parents and siblings	No major difference	
3. Longevity of parents		
Fathers	51.7 Yr.	54.5 Yr.
Mothers	60.4 Yr.	58.5 Yr.
4. Health during childhood	No major difference	
5. Economic and cultural background in childhood	No major difference	
6. Exposure to infection and trauma	No evident difference	
7. Constitutional factors detectable by physical examination or routine diagnostic tests	No evident difference	
8. Psychosocial environment in childhood		
A. Without undue demands, conflicts, or deprivations	15	6
B. Heavy demands, frequent conflicts, and deprivations; insecurity	5	14
9. Psychosocial environment in adult life		
A. Without undue demands, conflicts, or deprivations	12	0
B. Heavy demands, frequent conflicts, and deprivations; insecurity	8	20
10. Marital relationship		
Single	13	6
Married, now or formerly	7	14
Instances of marital incompatibility	3	15
Total number of separations or divorces	2	8
Total number of children	2	16
11. Occupational satisfaction		
Satisfied	20	3
Dissatisfied	0	17

proportion of the "sickest" members of the two American groups had experienced divorces; separations; conflicts with parents, siblings, husbands, and wives; uncongenial living and working arrangements, and the like and that relatively few of the healthiest members of these groups had had comparable experiences. The data from the Chinese study appears to be consistent with this. But again, this difference was not absolute. While it could be shown that a great many of the observed clusters of illness occurred during periods of "objective," demonstrable interpersonal difficulties and conflicting social demands, it could also be shown that such situations not infrequently occurred both in the healthiest and unhealthiest members of all of the groups without being associated with any significant symptomatic disturbances.

This was in part a matter of degree. Any severe disruption of interpersonal relationships and any marked change in the demands of the social situation was almost invariably found to be associated with some minor change in mood, thought, and behavior and some minor disturbances of bodily processes; but in many instances, even though the disruption in the social or interpersonal life of the informant was objectively a major one, the symptomatology associated with this could not be considered

to be of sufficient magnitude or duration to represent an "illness." On the other hand, some objectively minor disruptions in the life of a person might be temporally associated with a major disturbance of mood, thought, and behavior, or major bodily illness, which could not be explained on the basis of the interposition of any external causative agent. Thus, it is clear that, while there is a positive association between the occurrence of illness and the occurrence of objective changes in interpersonal relations and in the demands of social situations, and probably a significant one, this cannot be invoked as an adequate explanation of the changes in the amount of illness exhibited by an individual informant from time to time.

If one relies solely upon measurements which can be confirmed by independent observers and by external records, one can say only that adverse childhood experiences, difficulties in adult interpersonal relations, and heavy demands from the social environment are positively associated with an increased susceptibility to illness of all forms, and from this data alone it seems very likely that they have an important effect upon human susceptibility to illness in general.

4. However, it is believed that the individual man does not react to the events and situations in his social environment simply

as they appear "objectively" to other people. It is, of course, true that men in general have similar needs for protection, dependency, human association, sexual fulfillment, and the like, even though these vary somewhat in degree from man to man. And it is also true that people sharing the same culture and the same social niche share many perceptions which are based upon their common learned behavior, their common experiences, and their shared values and aspirations. Because of this, one might expect that members of each of these homogeneous groups would find many disturbances of interpersonal relations and many types of social demands and deprivations, similarly difficult to cope with; therefore, one might expect that a majority of the members of each group who encountered certain types of difficult life experiences would have adverse reactions to these. Nevertheless, from what we know of man as a living system, there is no reason to expect that all people will react alike to the same situation.

It is the present belief that the reaction patterns of each person are in part determined by his constitutional make-up and in part by his life experiences, during which he "learns," in the broadest sense of the word, that some types of situations are peculiarly threatening to him and that others are peculiarly desirable. It is thought that each man reacts to each situation he encounters in life in terms of his total perception of the meaning of that situation, using the term "perception" as including both conscious and unconscious processes and using the word "situation" to mean not only the total configuration at that point in time, but also what this configuration symbolizes to him. If we accept these hypotheses, then, in order to ascertain how a man will react to the situations which he encounters, it is necessary to weigh each situation in terms of its peculiar meaning for him. This cannot be done simply by using evidence from outside observers. One must obtain from the person his own evalua-

tion of the meaning of each situation, and the observer, himself, must also make inferences about the meaning of these situations, based upon his own knowledge of the informant's past experience and his estimation of the informant's needs, his drives, and his goals. In doing so, one is clearly introducing the possibility of personal bias on the part of the observer and on the part of the subject, himself. Nevertheless, some attempt must be made to make such an assessment, if one is to estimate the meaning to the person of events and situations in his social environment and the influence which his attempts to adapt to these have upon his health.

Such a careful assessment of the life histories and significant conflicts was carried out with all of the Chinese subjects and a selected sample of the two American groups, including both the most frequently ill and the least frequently ill. Although these evaluations were made by a number of observers, there was general agreement that in all of the cases studied clusters of illness often occurred during periods significantly stressful for the person, when he was striving to adapt to what were for him highly pertinent, conflicting, and often seriously threatening demands arising out of his relation to his total environmental constellation, as he perceived it (Fig. 8; the informant whose clusters are diagrammed in Fig. 7). It is our general inference, based upon our observations, that, in the individual members of all three groups, clusters of illness of all sorts most often occurred in periods when the subject was experiencing significant difficulty in his attempts to adapt to the conflicting demands of his total environment as related to his own needs.

5. The difference between the amount of illness experienced by the "most healthy" and "least healthy" members of each group might well be explained upon the basis of constitutional differences in general susceptibility to illness. Therefore, members of all three groups, including those having many illnesses as well as those having few, were

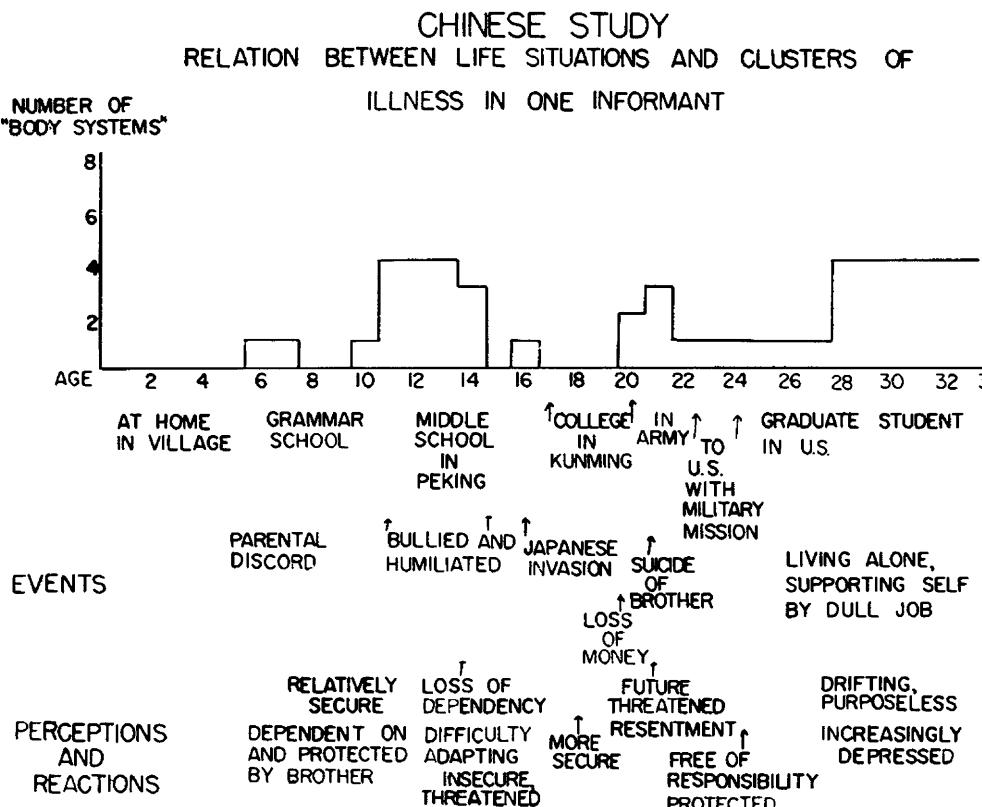


Figure 8

examined with regard to the occurrence of hereditary diseases, the health and longevity of their parents and siblings, and evidences of constitutional differences, such as anatomic abnormalities and metabolic defects, which might predispose to illness. Thus far, these have not been found to be significantly different in the healthiest informants as compared to the unhealthiest; but other constitutional factors not detectable by our methods may well have been present. They could explain why some people have much more illness during their lives than do others; but some additional factor would seem to be necessary in order to explain the "clustering" of illnesses. The most reasonable explanation for this is that the changing relationship between the informants and their external environment influenced their susceptibility to illness in general.

It is our inference that constitutional and hereditary differences in general suscepti-

bility to illness were very likely present among the members of these groups; but we do not believe that they are responsible for the phenomenon of "clustering."

6. From these general observations upon the three groups, and from the characteristics of the healthiest and unhealthiest members, it appears that the members of these groups who were most healthy were people who were peculiarly well adapted to the particular life situation in which they found themselves, even though there might have been other life situations to which they could have adapted less well. The opposite was true of those who were most ill. From this we make the general inference that good health among our informants occurred when a person existed in a life situation which satisfied his own peculiar needs, however these might differ from those of the population in general, and that ill health occurred when a person existed in a life situation which placed excessive demands

upon him, or which failed to satisfy his own peculiar needs and aspirations.

Many of the least healthy did indeed appear to be people who had been so crippled by their early life experiences, or who possessed so many conflicting drives, that they could scarcely have adapted to any life situation; but some of the least healthy members of all three groups were persons of outstanding intelligence, superior education, and high standards of conduct, who were resolutely pursuing socially desirable goals in the face of repeated frustrations and overwhelming demands arising out of their life situations.

Some of the healthiest people were those who had spent their childhood in benign and secure surroundings and who appeared to have learned from their parents consistent patterns of mature behavior in dealing with life crises, and some of these people appeared to have dealt with their needs and the demands of their life situations with outstanding ability. But there were other healthy people who had encountered a variety of vicissitudes in their childhood environment and who seemed to have no special adaptive capabilities other than those peculiarly suited to the adult environment in which they found themselves, and there were still others who appeared to have maintained their health at the expense of markedly restricting their adult lives, establishing no heterosexual relationships, taking no responsibilities for the welfare of others, and exhibiting an almost pathological opportunism, shallowness of interpersonal relations, and callous indifference to the consequences of their decisions.

All of this we take to confirm the evidence, obtained from the life histories of many persons, that illness often occurs when a person perceives his life situation as peculiarly threatening to him, even though this life situation may not appear to be threatening to an outside observer, and that people who maintain good health in a setting of what are "objectively" difficult life situations do not usually perceive these situations as difficult.

Comment

From the physicochemical point of view, the individual man may be regarded as an independent living system, surrounded by an "environment" with which he constantly interrelates. The integrity of this system is ultimately dependent upon the maintenance of a dynamic equilibrium among the molecular configurations which make up the cells and upon the maintenance of the general integrity of the larger configurations which make up the various organ systems. Any disturbances of the human system which arise out of its relation to its environment are ultimately dependent upon the addition of energy to the system, the subtraction of energy from it, or the initiation of some process which alters the energy exchanges within it. Electric shock, heat, roentgen rays, and food are examples of environmental agents which disturb the system by adding energy to it; cold air and water are examples of agents which disturb the system by subtracting energy from it; and KCN, cyclopropane, and diphtheria toxin are examples of agents which disturb the system by interfering with or altering energy transformations within it.

The great majority of toxic agents, congenital anomalies, vitamin deficiencies, and pathogenic micro-organisms act primarily by disturbing energy transformations within the system; but their action is not simply analogous to that of KCN. While most of them do to some extent directly disturb energy transformations and destroy cellular configurations, they also set in motion adaptive reactions on the part of the host which have a similar effect. A large proportion of the disturbance created by any toxic or infectious agent is created by the adaptive efforts of the host, itself, and this is true, in fact, even in the case of thermal and mechanical injuries. These agents act not only as sources of energy and of direct interference, they act also as "signals" which set in motion counteractions of the host which are both local and generalized and which are, to a certain extent, "nonspe-

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cific"—a phenomenon to which Selye has applied the term, "nonspecific stress." In some disturbances, of which rheumatic fever and glomerulonephritis are prototypes, the "disease" consists almost entirely of the host's reaction, and the direct action of the agent is probably very small—although circulating antigen remains an important part of the mechanism.

Man is not limited to reacting to that part of his environment which impinges upon him directly. He shares with the higher animals organs of special sense and a central nervous system, which enable him to react to aspects of his environment which are separated from him both in space and in time. These aspects of the environment, which make up what we have called the "social environment," are no less "real" and "physical" than any other, and their division into a separate category is in part arbitrary, for the organism adapts to its environment as a whole, rather than to a part of it. However, there are some theoretical advantages to making this distinction, because there are certain special aspects of the mechanisms involved in adaptations to the "social environment."

The disturbances of the human system which arise out of its relation to its social milieu must arise through a mechanism somewhat different from that involved where there is a direct encounter with physical forces, infectious organisms, toxic agents, or dietary disturbances; for, as we have said, each of these latter acts directly to produce a disturbance in the human system, either through the application of energy from external sources or through directly altering or interfering with the normal energy transformations within the system itself, and the direct action of these agents can be regarded as a "cause" of any "disease" which may result. But man's social environment does not act upon him in any such manner; it is entirely "at a distance," and the person receives no energy from it except that minute amount which impinges upon his organs of special sense. Thus it acts upon him not

at all as a source of energy but entirely as a "signal." It might be said that what man does is to "scan" his social environment with his organs of special sense, which pick up "information" that is transmitted to his brain. His reaction to his social environment is therefore in proportion to the meaning of the "information" which he receives from it, rather than to the duration or magnitude of any of the events, situations, or other configurations which make up the signal. Thus it becomes apparent that the clinical observation that "man reacts to his social environment as he perceives it" cannot escape being correct, for the physical relationship between man and his social environment is such that he has nothing to react to except his perceptions.

This point is fundamental to understanding the implications of terms such as "the stress of modern living," "emotional stress," or "life stress." The term "stress" was brought into medicine from physics, where it is used to refer to a force within a solid body which is opposed to an external force, or "load." In physics, "load" and "stress" are proportional. In medicine, on the other hand, the internal response is seldom proportional to the external load, and, in the case of "life stress," it is almost never so. The changes which take place within the human as he relates to his social environment are derived entirely from his own energy stores and are set off entirely by his own regulatory mechanisms. The "stress," if this term may be used, is *sui generis*; the environment acts only as a signal.

The adaptation to the social environment is therefore mediated initially by the organs of special sense, which pick up information that is transmitted to the brain. The brain organizes all of man's reactions to his social environment and, in fact, makes possible the very society in which he exists. The brain presumably receives all of the mass of information supplied to it by the sense organs at any one time; but it selects those items

to which it will react.[‡] However, the human brain generally reacts to the total life situation of its possessor at any given point in time, integrating the information which it receives into meaningful patterns and reacting to these patterns on the basis of information previously supplied to it, and that which was "built into it." Some of the information received by the brain enters "awareness" or "the conscious," and some does not, and reaction to the latter may be as vigorous as to the former.

There are many factors which determine how the brain will evaluate any one body of information which is brought to it. Among these is the "constitutional endowment" which includes much more than gross and fine structure; it includes such "built in" information as that which informs a newborn infant that a nipple placed in the mouth should be responded to by sucking; it includes the biological drives which shape a good deal of later behavior, and it includes all of those as yet undefined factors which are included in the term "constitutional temperament." In addition to this, there are the residual traces of the past information which has entered the brain, only part of which are available to conscious memory. This "learned endowment" of the person includes the knowledge, attitudes, beliefs, and behavior patterns which he shares with his society in general and the residual traces of the experiences peculiar to his own life. All of these, as well as the state of the man in general, and of his brain in particular, at the time the information is received

are important determinants of its evaluation.

The function of the brain as an adaptive organ is not only that of integrating and evaluating the information which it receives from various sources, but also that of arriving at a solution which makes possible an adaptation to all of the requirements of human life. This operation, which is carried on largely outside of the realm of consciousness, must be extremely complex. Many of the adaptive reactions of the human organism—such, for example, as the adaptation to changes in CO₂ concentration in the blood, are organized at a cellular or organ level and can operate independently; but the more complex adaptations to the social environment, involving the actions of the organism as a whole, are organized and guided by the central nervous system. In order to facilitate the execution of such adaptive reactions, the brain is capable of enhancing, altering, diminishing, or even suspending, the functions of organs or cellular systems which might otherwise proceed automatically. The extent to which it is capable of influencing the entire internal economy is not generally appreciated, and it is probably for this reason, more than any other, that the effect of adaptive reactions upon human health is often underestimated. The brain has available to it as effector devices the "voluntary" nervous system, the "autonomic" nervous system, and the glands of internal secretion, and it appears to be capable of influencing any bodily process which is subject to the influence of any of these regulatory mechanisms. Furthermore, since the gross behavior of the organism is controlled by the central nervous system, all that may be affected by behavior, including total energy expenditure and the intake of foods, fluids, and potentially toxic substances, is ultimately under its influence also. Thus the potential capacity of the central nervous system for altering bodily processes is enormous.

Table 4 is a list of some of the indicators of bodily function which have been observed

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TABLE 4.—*Some Bodily Functions Which Have Been Observed to Change During Adaptations to Experimental Life Situations in the Laboratory*

Organ System	Function
Brain	Mood-thought-behavior, electrical activity of cortex, capacity to perform psychological tests, reaction to pain
General Metabolism	Oxygen consumption, CO ₂ production, nitrogen excretion, blood glucose and ketone concentration, circulating eosinophiles, 17-hydroxycorticosteroid excretion
Circulatory	Cardiac rate, rhythm, electrical activity, output, stroke volume, exercise tolerance
Blood	Blood pressure, peripheral resistance, arteriolar and capillary tone Pulsation and contractility of cerebral vessels
Respiratory	Relative viscosity, clotting time, erythrocyte sedimentation rate, prothrombin time, "sludging" phenomenon Nasal secretion (amount and nature), redness, engorgement, edema; reaction to pollen, irritants, humidity, temperature Bronchial secretion, spasm Diaphragmatic movement Pulmonary ventilation
Gastrointestinal	Secretion of saliva Esophageal motility Gastric motility, redness and friability of mucosa, secretion of acid, pepsinogen, mucus, reaction to food, irritants, autonomic drugs Motility of duodenum and small bowel Motility, secretion, blood flow, pH, friability of mucosa, and lysozyme secretion of large bowel
Genitourinary	Renal blood flow, glomerular filtration rate, excretion of water, electrolytes, glucose, ketones Bladder motility
Bones and joints	Tonus of striated muscles
Skin	Temperature, reactive hyperemia threshold, itching, sebum secretion
Eye	Intraocular pressure, corneal vascularity, tearing

to be modified as human subjects adapt to experimental life situations in the laboratory.³ These experimentally modifiable functions involve a majority of the organ systems and include processes of various types. The evidence from the laboratory suggests that there is no aspect of the human system which may not take part in, or be influenced by, adaptive reactions initiated by the brain in response to configurations of the social environment. All bodily processes may be so affected, and they may be enhanced, attenuated, stimulated, or depressed, to whatever degree each process is amenable to hormonal, nervous, or circulatory control, or subject to the influence of diet or activity. The effects of these alterations in body function may include increased vulnerability to tissue damage^{4,5}; thus they may lead to the development of pathological processes which are irreversible and which may be permanently crippling, or even fatal.

Therefore, laboratory investigations and theoretical considerations, as well as clinical observations, provide good reason to believe that all "disease processes" may be to some extent influenced by the host's adaptation to his social environment. Some, being more labile, and involving bodily functions that are rapidly and markedly altered by nervous and hormonal influences, may respond rapidly and dramatically to the host's adaptations; others, less labile, and involving bodily

functions that are more autonomous or slowly cumulative, respond less rapidly and dramatically, but perhaps in the long run to an equally great degree.

However, the nature of human adaptive reactions is such that some bodily processes are much more frequently disturbed by social adaptations than are others. In organizing adaptations to the social environment, the brain evidently utilizes all of the effector systems which are available to it, to whatever extent they are needed; but some adaptive reactions, like the sucking reflex of the baby, appear to be "written into it" and are used more often than others. They appear very early in life and are frequently evoked by a variety of stimuli thereafter.

An example is the nasorespiratory protective, associated with engorgement, redness, and hypersecretion of the nasal mucous membrane, blockage of airways, tearing, bronchospasm, and increased bronchial secretion. This reaction pattern is very frequently exhibited in the course of everyday life, being evoked by exposure to dust, smoke, fumes, cold air, and infectious agents, as well as by any situation which leads to crying. It has a direct adaptive value in each case, except in the case of crying. Here it may have an adaptive value of second order in that it may serve to give vent to emotion; but there is no possibility

that it will shut out or wash away the cause of the trouble, as it might in the case of noxious fumes. When exhibited under circumstances of grief, therefore, this reaction pattern has a degree of biological inappropriateness about it which is similar to that of the involuntary defecation that may occur with fear, or the finger-tapping of a tense man.

Some people, for reasons not entirely clear, exhibit this reaction pattern much more frequently and continuously than do most members of the population. It may well be that genetic factors are important in determining who will use this pattern excessively and inappropriately; but there is also good reason to believe that some people are conditioned by their life experiences so that they display this pattern when faced with various life situations which only in a symbolic sense require "shutting out and washing away." In any case, those who readily display this reaction make up a majority of those who have vasomotor rhinitis. They are hyperreactive to a variety of nasal stimuli, including infectious agents and allergens. Their chronic nasal engorgement and impaired drainage makes them more susceptible to sinusitis, and their capacity for developing bronchospasm and increased bronchial secretion renders them prone to bronchitis and asthma. Clinical observations have shown that all of these illnesses, each of which has several "causes," are more likely to appear when the host is facing a life situation which he perceives as difficult and to which part of his reaction is this nasorespiratory protective reaction.

This reaction pattern, and those involving the upper and lower gastrointestinal tract, the cardiovascular system, and the blood vessels of the head, are so exceedingly common that, along with the various symptoms of anxiety, tension, depression, and asthenia, they account for the majority of the symptomatic complaints experienced by the general population. This group of phenomena is often so easily associated with the patient's attitudes and emotions and so

clearly "inappropriate" to the situations which evoke them that there has been a tendency to look upon them as a special category of illnesses, called "psychosomatic"; however, except for their lability, and the frequency of their appearance, there is no reason to believe that these reaction patterns, and the illnesses associated with them, are different from any other.

One would expect that a system, constructed as the human system is, would react to life experiences by manifesting various changes in its behavior, thought processes, mood, and bodily functions, and one would expect that these manifestations would usually take place simultaneously or consecutively, but that there would not necessarily be any fixed relationship between them. The findings from our investigation support this hypothesis. The occurrence of illnesses in "clusters," with each "cluster" occurring during a period of adaptive effort and consisting of a variety of illnesses involving several body systems and appearing consecutively or concurrently, is what one would expect if this hypothesis were correct. The great majority of the illnesses which make up these clusters involve micro-organisms, toxic material, physical traumata, dietary disturbances, and other recognizable causative agents. In many cases the form which a disease takes is in part dictated by this "causative agent" and there is much reason to believe that the illness could not appear in just this form in its absence. Even where the illness appears to be simply the result of the excessive or prolonged use of a "biologically inappropriate reaction pattern" it may well be that the propensity of the person to react in this manner has a genetic or constitutional basis. However, the evidence from these studies also indicates that although man is surrounded throughout his life by a host of potential "causative agents" of disease and carries with him always his genetic susceptibilities, he develops illness most frequently at times when he is having difficulty adapting to his environment. It appears that the disturbances of bodily

function, mood, thought, and behavior which occur during periods of adaptive effort make possible the appearance of disease processes which might not otherwise manifest themselves. It is our general inference that man's relation to his social environment has relatively small influence upon the form which illnesses will take but that it has a major influence upon the time and the situation in which illnesses will occur and the course which they will pursue.

Conclusions

1. Members of the otherwise homogeneous adult populations exhibit differences in their general susceptibility to illness such that some persons experience a greater number of illnesses per unit time than do others.

2. Those persons exhibiting the greater susceptibility to illness exhibit a greater susceptibility to all forms of illness such that the greater the number of episodes of illness which they experience the greater the number of organ systems which are likely to be involved. Those having the greater number of bodily illnesses are likely to experience more accidents and more disturbances of mood, thought, and behavior.

3. In general, illnesses are not distributed at random over the life of a person but often appear in "clusters." A cluster is usually of several years' duration and includes a number of illnesses of various etiologies involving a number of organ systems and appearing concurrently or consecutively. Such clusters alternate with periods of relatively good health which are of variable duration.

4. Clusters of illness most often appear when a person is having difficulty adapting to his environment as perceived by him. Those persons who exhibit a high susceptibility to illness are those who exhibit the greatest difficulty in adapting to their life situations.

5. Differences in the amount of illness exhibited by different men appear to be in part the result of inherent differences in their adaptive capacities and in part the

result of differences in the environmental situations which they encounter.

6. Man's relation to his social environment appears to have small influence upon the form which illnesses will take but a major influence upon the time and the situation in which illnesses will occur and the course which they will pursue.

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ABSTRACT OF DISCUSSION

DAVID E. ROGERS, New York: Dr. Hinkle has presented some extremely interesting material derived from study of three relatively homogenous groups of people. His data suggest that human reactions to environmental stresses and strains may determine, in part, the frequency with which they become ill.

Certain findings in the present study seem of particular interest to me. Dr. Hinkle has shown a positive correlation between the total number of illnesses sustained by each person and the number of organ systems involved. This is not what one would expect if specific structural defects in one organ system were responsible for frequent and recurrent illness. He has also shown a positive correlation between the total number of major and minor illnesses sustained by the same person and has indicated that people with many illness episodes have more accidents. These data indeed suggest that susceptibility to illness may be related to broad changes in the human host rather than local organ susceptibility.

Other studies lend weight to Dr. Hinkle's hypothesis that reaction to stress perceived, but not directly experienced, may heighten susceptibility to illness.

For example, it has been shown that a wide variety of nonspecific stimuli which alter the respiratory tract mucosa of mice can lead to activation of a latent viral pneumonitis in these animals. Activation of the infection apparently results from the local mucosal change, regardless of how it is produced. Dr. Harold Wolff and his associates have clearly demonstrated that human reactions to stimuli of a perceptual rather than physical or chemical nature can produce definite, measurable alterations in mucosal structure and function. These mucosal changes mimic those seen following direct chemical or allergenic insults. It thus seems reasonable to believe that changes in the host which result from his reactions to his environment may predispose to increased episodes of illness.

I am inclined, however, to differ with Dr. Hinkle in certain of his conclusions. I am reluctant to assign any causal relationship to the finding that the majority of patients having a large number of ill-

ness episodes have more severe psychosocial conflicts. In the body of his paper Dr. Hinkle indicates that a positive correlation exists between these two phenomena without attempting interpretation. In his discussion he assumes a causality which I do not believe is justified from the material he reports.

I am not convinced that the data presented demonstrate a clear relationship between disorders of mood, thought, and behavior (subjective data) and the number of total illnesses (objective data) sustained by the persons studied. Further, the evidence presented to substantiate this correlation is derived from studies on the Chinese group, where actual records of previous illness were lacking. Data obtained from personal recall alone introduces an individual memory bias and distortion which cannot be properly evaluated.

Such retrospective data can be misleading. The wide discrepancies in the reported incidence of congenital anomalies following maternal rubella furnish a striking example of the difficulties involved in judging the accuracy of recalled information. Original studies, in which mothers recently delivering babies were interviewed, indicated that an 80% chance of fetal congenital anomalies existed when maternal rubella occurred during the first trimester of pregnancy. Subsequent prospective studies, in which expectant mothers contracting rubella during the first three months of pregnancy were followed to term, have indicated an actual incidence of congenital anomalies of less than 20%. In reviewing these studies it appears clear that mothers who delivered abnormal children could recall episodes of German measles occurring during pregnancy while those who had healthy infants could not.

I feel this aspect of the present study will be strengthened if testing procedures, which give us more understanding of the patient's inner concept of self and his life situation, substantiate the present hypotheses. I am certain, as is Dr. Hinkle, that the way socioenvironmental problems are perceived by the person who is experiencing them has considerably greater meaning than our external evaluation of their significance. In the present study it is of interest that in certain of the persons studied a striking negative correlation existed between the life situations as externally evaluated and amount of illness experienced.

I think this finding may indicate, in part, how difficult it is to assess accurately, as outside observers, the true meaning and flavor of life situations to the persons who are living them.

Testing procedures such as the Q-sort technique, projective questionnaires, and the Thematic Apperception Test, which allow patient expression of attitudes toward self and surrounding, might further define the type of personality setting and

situation in which illness ensues. Such data would require less external interpretation by the investigators and might furnish more valid correlations with objectively recorded illness.

Dr. Hinkle has indicated that such studies have been carried out on some patients. I am thus anxious to learn whether any correlations can yet be made between findings derived from such inner reference testing procedures and the incidence of illness in these groups.

I think Dr. Hinkle is to be congratulated in objectively exploring an area of vast importance to all of us concerned with human illness. To date, the investigative tools which can be focused on the complex problem of man's relationship to his abstract environment are relatively crude. Nevertheless, during recent years Dr. Hinkle and Dr. Wolff have reported an increasing number of controlled observations on the changes in the human organism which can result from perceptual stimuli. This type of approach has already yielded considerable data which can be checked, retested, and subjected to critical evaluation by other investigators.

In all other medical disciplines, the scientific method has rapidly increased our ability to understand and deal with disease. More precise and verifiable knowledge about the type of life setting in which illness is likely to arise studied in this manner may allow us to deal more effectively with the problem of the frequently "sick" person in the future.

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